NEW JERSEY STATE HIGHWAY DEPARTMENT

ANALYSIS OF NEWARK AIRPORT AND BENEFITS TO ACCRUE TO THE NEW JERSEY-NEW YORK METROPOLITAN AREA

Consultants Report
Date Due

HOWARD, NEEDLES, TAMMEN & BERGENDOFF
CONSULTING ENGINEERS

JANUARY 1962

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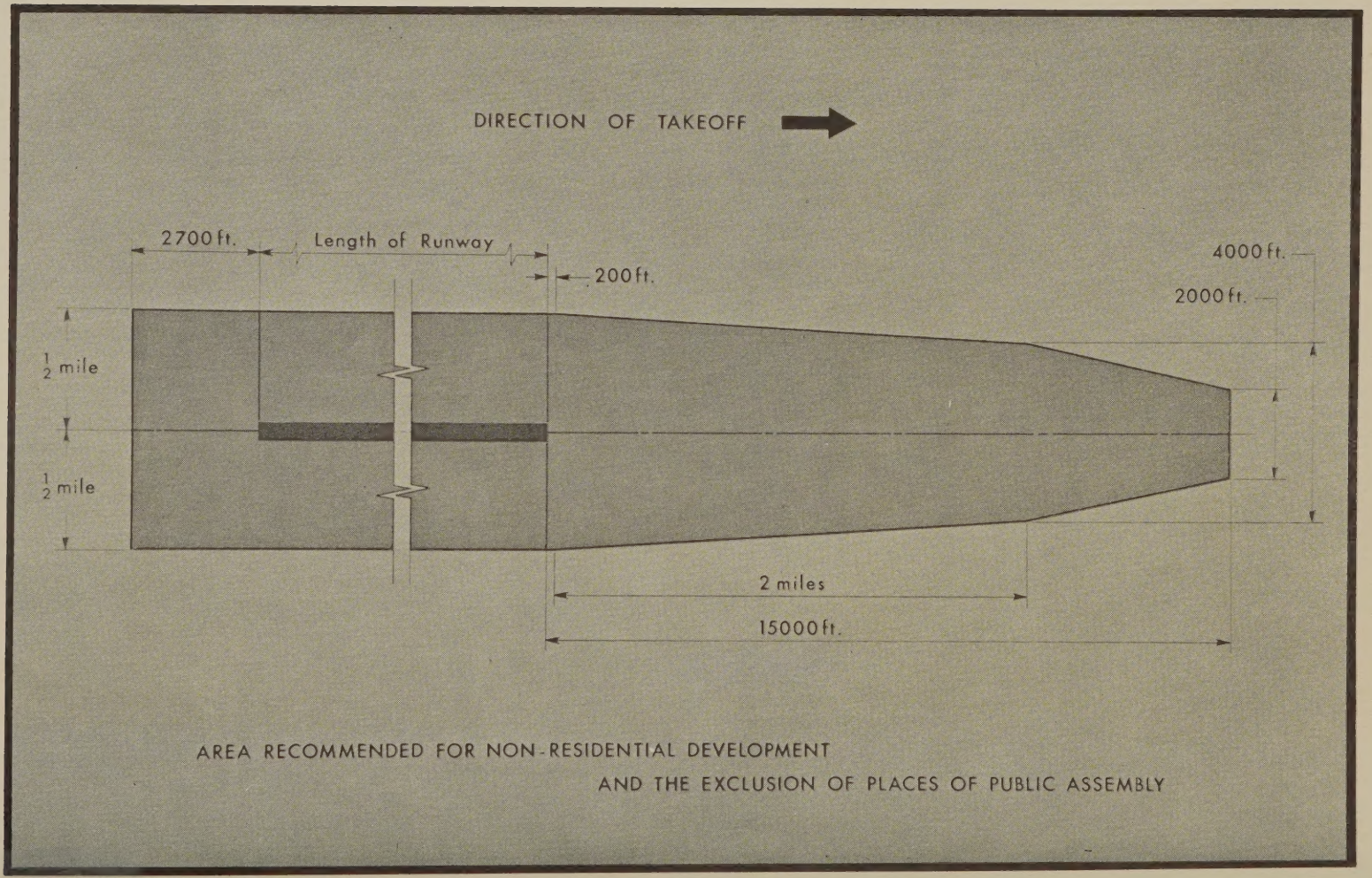
DIRECTION OF TAKEOFF
2700 ft.
Length of Runway
200 ft.
4000 ft.
2000 ft.
1/2 mile
1/2 mile
2 miles
15000 ft.
AREA RECOMMENDED FOR NON-RESIDENTIAL DEVELOPMENT
AND THE EXCLUSION OF PLACES OF PUBLIC ASSEMBLY

NEW JERSEY STATE HIGHWAY DEPARTMENT

ANALYSIS OF
NEWARK AIRPORT
AND
BENEFITS TO ACCRUE TO THE
NEW JERSEY-NEW YORK
METROPOLITAN AREA

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January 12, 1962

Hon. Dwight R. G. Palmer
State Highway Commissioner
New Jersey State Highway Department
Trenton, New Jersey

Dear Commissioner Palmer:

We transmit herewith our detailed Report regarding the prospective future for Newark Airport. Our more important findings are summarized in this letter for your convenience.

Our study has followed your instructions on November 15, 1961, as to the scope of our work and the meetings to be held with the Port of New York Authority, which operates Newark Airport, the interested air line officials, and officials of the Federal Aviation Agency, both at the regional office and in the Newark Airport Control Tower. Further information regarding these meetings appears in our detailed Report.

Following the preliminary arrangements made by you, we met on November 20, 1961, with Mr. Austin Tobin, Executive Director of the Port of New York Authority, and Mr. John Wiley, Director of Aviation for this Authority. This was an extended discussion in which the future planning of the Port Authority in respect to Newark Airport was very fully presented. This was followed by further meetings of our staff with Mr. Arthur Fallon, Deputy Director of Aviation, and Mr. Edward

Hon. Dwight R. G. Palmer January 12, 1962

Olcott, Chief, Port Development Planning Division. All of these discussions were cordial, comprehensive and very helpful to us.

Following your further arrangements, we met on December 12, 1961, with Mayor Steven J. Bercik, of Elizabeth, and on December 20, 1961, with Mayor Leo P. Carlin, of Newark. These meetings were cordial and very helpful from our point of view. Mayor Bercik expressed appreciation of our visit and our extended discussion. As is well known, his present views are very positive that noise abatement and safety are of paramount importance in respect to Elizabeth. At the same time he is sincerely interested in the prospect of a full-scale unbiased study of the role of Newark Airport in the economy of Elizabeth. Mayor Carlin entered into a wholesome extended discussion, but expressly reserved any opinion until further study and thought could be afforded.

On December 20, 1961, we likewise held a meeting with the officers and several of the commissioners of the Essex County Park Commission in Newark. After full presentation of our studies, we were advised that since future air patterns relative to Weequahic Park would be substantially unchanged from the present, they saw no reason for concern on their part relative to the future developments to come at Newark Airport.

We have reached the following conclusions:

1. It is logical and essential that Newark Airport shall be developed to serve permanently as a major airport in the New Jersey-New York Metropolitan Area, capable of providing for a 50% increase over

present peak-hour traffic volumes. The present and future industrial and commercial life of northern New Jersey demands a modernized and expanded Newark Airport.

2. Newark Airport's runways can be constructed initially up to 8,000 feet in length with an actual reduction in noise levels over Elizabeth and Newark. Extension of such runways to 10,000 feet in length with equivalent increases in loads and flying ranges should be anticipated as aircraft improvements are made in the future, with only minor effects on noise levels.

3. Transcontinental non-stop flights will unquestionably be possible within the comparatively near future into and out of an expanded and modernized Newark Airport.

4. If expansion should start promptly, it would probably be four or five years before Newark Airport would be rebuilt and in full operation according to the new plan to be selected.

5. We have studied three alternate plans for an expanded Newark Airport to serve transcontinental non-stop flight. Each appears capable of construction and operation and would afford substantially increased traffic volume. No selection of a preferred plan is suggested herein.

6. An expanded Newark Airport will require revisions in present highway plans to accommodate essential changes in locations

Hon. Dwight R. G. Palmer January 12, 1962

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11. It is only a matter of time before another major airport in addition to the expanded Newark Airport will be essential for adequate air transport service for northern New Jersey and for supplementing the other Airports in the New Jersey-New York Metropolitan Area. The physical limitations surrounding Newark Airport necessitate corresponding limitations in our thinking regarding the future service to come from the expanded Airport. The future population expansion and growth in northern New Jersey, accompanied by the certain and continuing industrial and commercial growth in this area, will create air transport demand which must eventually outstrip the services to be rendered by a fully expanded Newark Airport. Only another new airport can meet these future demands.

12. The expansion and modernization of Newark Airport should be started at the earliest possible date.

Very sincerely,

Ernest Needles.

HOWARD, NEEDLES, TAMMEN & BERGENDOFF

ERN:sab

CHRONOLOGY OF PRINCIPAL MEETINGS

Date	Meeting between members of HOWARD, NEEDLES, TAMMEN & BERGENDOFF and:
Nov. 20, 1961	Officials of the Port of New York Authority.
Nov. 24, and Dec. 12, 1961	Mr. W. J. Conrad, Chief Controller, and other FAA personnel at the Newark Airport Control Tower.
Nov. 27, 28, 1961	Officials of the Housing and Home Finance Agency, the Federal Housing Administration, and the Public Housing Administration.
Nov. 29, 1961	Officials of Eastern Air Lines, United Air Lines, American Airlines, and the Air Transport Association of America.
Nov. 30, 1961	Officials of the Federal Aviation Agency, Eastern Region Office.
Dec. 1, 1961	Officials of United Air Lines, American Airlines, and the Air Transport Association of America.
Dec. 12, 1961	Mayor Steven J. Bercik of Elizabeth, New Jersey.
Dec. 20, 1961	Officials of the Essex County Park Commission.
Dec. 20, 1961	Mayor Leo P. Carlin of Newark, New Jersey.
Dec. 22, 1961	Capt. Harry Clark, Representative, Air Line Pilots Association; former Chairman of TWA Central Air Safety Committee.

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INTRODUCTION

The State of New Jersey, through Commissioner Dwight R. G. Palmer of the New Jersey State Highway Department, has requested that a survey be made of the Newark Airport and its immediate environs, with the end in view of determining its full potentialities and the possibility of extending it beyond its present confines. This report covers the results of our independent investigation toward that objective.

We have given consideration to general airport planning requirements, have reviewed the present capacity of the airport, and have made studies to find how this capacity may be increased. We have attempted to take realistic account of:

1. Airport design factors
2. Present Newark Airport and facilities
3. Future aircraft operations
4. Methods for development of Newark Airport
5. Future aircraft developments
6. Accessibility
7. Economic effect on Northern New Jersey
8. Community response to airport problems

In the short time available it has not been possible, nor is it considered imperative at this stage, to determine the specific

economics of the various schemes studied. However, it is important that we determine generally if the present airport facilities are capable of expansion to be of greater value to Northern New Jersey, especially the area around Newark and Elizabeth, how this can be done, and the effect on the surrounding and directly adjacent areas. In like manner, we have considered it important that the future possible improvements be reviewed in respect to flying equipment, facilities, methods and controls, together with the impact of such possible improvements upon the utilization of Newark Airport in the next five to ten years. We have made no attempt to analyze and solve the overall problems of future air transportation in the great metropolitan areas of New York and New Jersey, except to make the observation that the magnitude and importance of air transportation in these areas will continue to increase for the indefinite future and that the problems to be solved in connection therewith will be increasingly complicated.

The results of our investigation are contained in the presentation and discussion of three basically different airport development plans. While several other plans have been considered, those shown are believed to be most worthy of consideration. The actual ultimate airport development might well be a combination of parts from the different plans, rather than strictly according to a plan as shown. Similarly, although each plan shows two main runways of equal length for transcontinental operations, it is entirely possible that one main runway of such length would be sufficient and the other main runway could be considerably shorter.

We are grateful to Commissioner Dwight R. G. Palmer and to the Port of New York Authority for their full cooperation in making existing data and records available; and to the airlines, the Federal Aviation Agency and the Air Line Pilots Association for their cooperation in reviewing and discussing airport planning considerations,

restrictions, rules and regulations. The Essex County Park Commission, and officials of the United States housing agencies have also been most helpful and cooperative. Mayor Leo P. Carlin, of Newark, and Mayor Steven J. Bercik, of Elizabeth, were cordial and helpful and expressed appreciation of being advised in advance of the general nature and result of our studies.

DESIGN FACTORS

INTRODUCTION

Because the airplane operates in a three-dimensional medium, the planning and design of an airline airport are necessarily complex tasks. The designer must consider all the functions that will be required of the facility. His master plan will take into account the level of operations that the projected aircraft "population" will achieve and provide the necessary runway capacity therefor. To match this capacity for landing and departing aircraft, there must be a carefully integrated and flexible plan for the many facilities of the terminal area that are basically auxiliary to the runways.

One of his prime considerations will be the control of traffic, in which are involved the relationship the site has with other airports, the location of obstructions which may encroach upon airspace, the complex airways structures, and the procedures to be observed under different conditions for approaches, takeoffs, and noise abatement.

He must consider the rightful desires of the airport's neighbors and in his planning explore every feasible scheme to find the one that, within the limits imposed by function, safety, and economy, will result in the least annoyance to the fewest people. Those principal

factors which would have a bearing on the planning for an expansion of Newark Airport are briefly noted below:

LENGTHS OF RUNWAYS

All other things being equal, the classification of an airport depends on the lengths of its runways. Technical Standard Order N-6b (dated October 3, 1958), of the Federal Aviation Agency, establishes 7500 feet as a sufficient length for a continental airport, that is, an airport serving long-range, non-stop flights, exclusive of coast-to-coast flights. It establishes 10,500 feet as a sufficient length for airports serving non-stop transcontinental flights. These criteria are given as normal maximums and are subject to adjustment based upon airport elevation, temperature, air routes served, and equipment operating from the airport.

The length of runway for takeoff, under the given conditions of runway slope and surface wind and temperature, is the limiting factor on the largest aircraft operating thereon. The pilot must be able to get his aircraft at least 35 feet into the air before crossing over the end of the takeoff runway. When this cannot be done with the payload and fuel the aircraft is expected to carry, the carrier is faced with the choice of offloading some of the payload or of changing the flight plan to include an intermediate fuel stop.

A landing aircraft must be able, within 60 per cent of the length of a runway, to clear the runway threshold by at least 50 feet, touch down, and come to a complete stop.

LAYOUT OF RUNWAYS

Wind Coverage Because of the variability of winds, most airports in the United States require a minimum of two runways at different headings. Generally, the primary runway of a two-runway

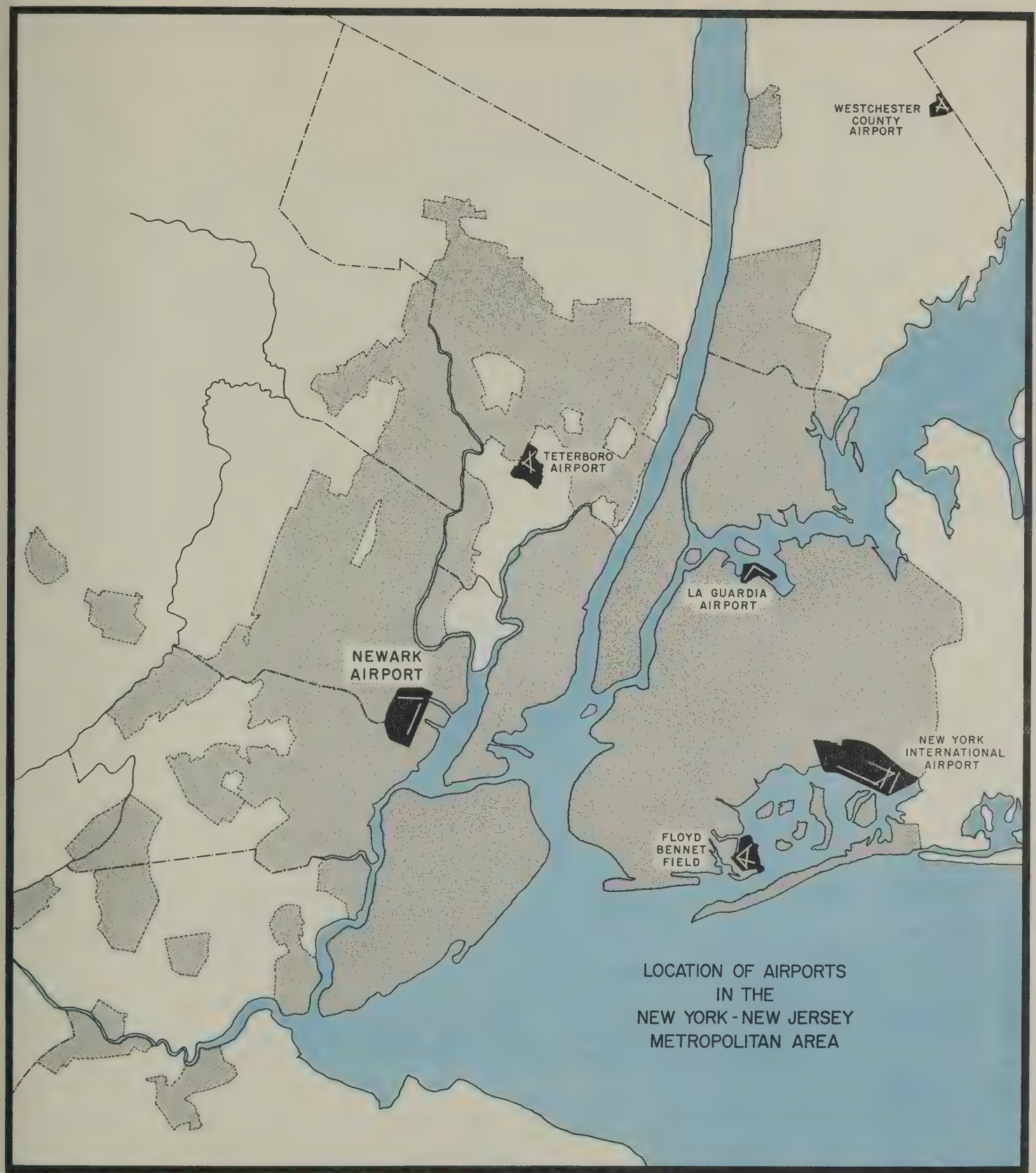
system is oriented in the direction of local prevailing winds to permit maximum use. The cross-wind runway is aligned, within the limitations imposed by the site and its surroundings, to permit operations when cross-winds are strong enough to make operation hazardous on the primary runway. Complete wind coverage is obtained when the runway system is so laid out that there is always one choice of landing and takeoff direction that will not subject the aircraft to a component of wind having a velocity greater than 15 knots acting at a right angle to the runway.

Complete coverage can seldom be attained with two runways; 95 per cent to 99 per cent is common. The more important the airport, the more justifiable is the effort to provide maximum coverage.

At major airports, the runway most nearly aligned with the direction of winds occurring most frequently is equipped with special aircraft aids for the making of instrument approaches to the airport.

Obstructions Hills, buildings, bridges, towers, stacks, masts, and the like are often found to penetrate the airspace of the airport's traffic area and its runway glide and takeoff paths. To the extent that such obstacles must be permitted to remain, they are a hindrance and a hazard to air traffic. They may affect the choice of runway alignment or require the displacement of thresholds.

Compatibility with Adjacent Facilities Where airports equipped with instrument landing systems are relatively near each other, it is important that their instrumented runways be so aligned that conflicts between traffic using these electronic systems in the separate terminal areas do not occur. At present the instrumented runways of the major airports in the New York terminal area are approximately parallel to each other, a condition which mitigates the disadvantages of close metropolitan airport proximity.



LOCATION OF AIRPORTS
IN THE
NEW YORK - NEW JERSEY
METROPOLITAN AREA

Noise The decibel is a measure of the very small increase in air pressure resulting from a sound wave. Because the human ear varies in its ability to perceive sounds of different frequencies, a number of scales have been worked out that measure noise on the basis of human response. Aircraft noise is frequently measured on a scale which gives greater weight to the high frequencies, to which the human ear is more sensitive, than to lower frequencies. This scale is the Perceived Noise decibel (PNdb) scale. A recorded aircraft sound-pressure level of 100 db is the approximate equivalent of 112 PNdb.

Something that is overlooked in many discussions of aircraft noise is the *duration* of sound at high-intensity levels. The ear appears to have a defensive mechanism which is able to reduce the effect of sharply-peaked levels of high intensity of very short duration. Thus, a particular level of noise experienced for a few seconds usually is less annoying to the hearer than a lower level of intensity experienced for a longer period of time.

Approach and Departure Procedures The Federal Aviation Agency controls aircraft movements in terminal areas. The controls consist of holding patterns, approach procedures and departure routes, the instructions of airport control tower controllers, and missed approach procedures. These are developed for each airport to provide the maximum of safety for the many combinations of movements which can take place simultaneously in a major terminal area.

Because many of the nation's major airports are close to residential neighborhoods, their operators have long realized that special procedures are needed to abate the noise level heard on the ground. At a number of airports, Newark included, the pilots of heavy aircraft are instructed to make turns which divert them from paths over dense residential areas, schools, hospitals, and churches. The necessary exception to such operations is the instrument approach. The electronic beams which give the pilot his course and glide slope cannot be curved, and the final approach,

starting 8 or 10 miles out from the end of the runway, must be made in a straight path.

Preferential runways are also designated, and their use, whenever weather conditions permit, frequently enables pilots to avoid passing over or near residential areas.

Capacity The flying public, shippers of air-cargo, and the postal service have come to expect dependability as well as speed from the scheduled airlines. Since the severest limitation that can be placed on an airport's landing and takeoff operations occurs when, because of poor weather, pilots must fly on instruments, the true measure of an airport's capacity must be taken in "instrument weather." During such weather, the rate at which takeoffs and landings can be cleared is necessarily less than the rates which are achieved in clear weather.

So many factors enter into the study of runway capacities that few means are available for *accurate* analysis of the capacity of a planned runway layout before it is built and in operation. By using consistent criteria, however, it is possible to compare the capacities inherent in different kinds of airport runway configurations. This has been done in our study of Newark Airport.

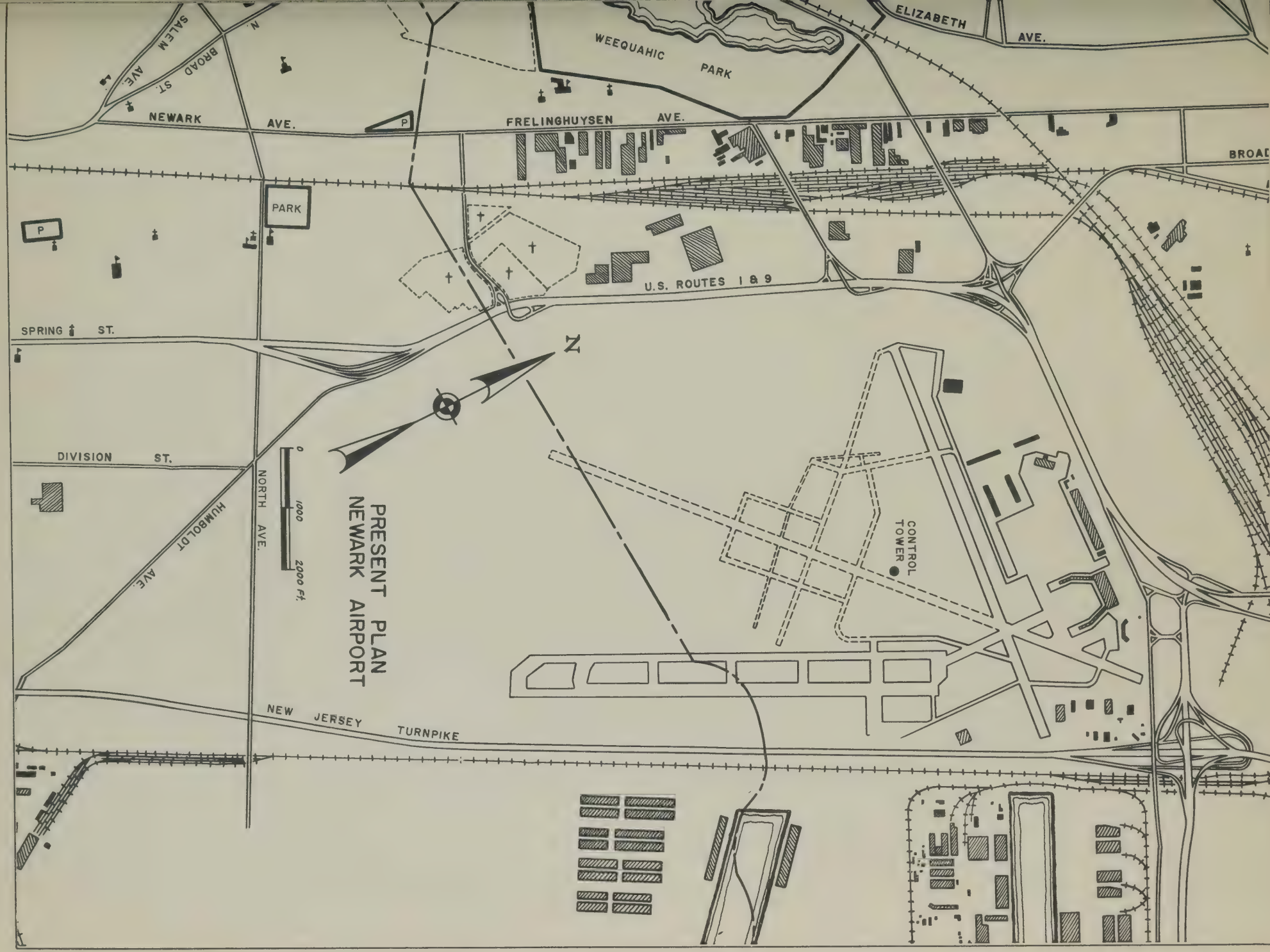
The Airport Terminal Area The goal in designing the terminal area is to provide for the orderly flow of people, cargo, supplies, and vehicles. To this end, a large number of facilities must be carefully integrated, among them: ground access connections; employee and passenger parking areas; the passenger terminal building with its own multiple functions; the cargo terminal buildings; the required and properly-arranged taxiway system; aircraft positions and passenger gates; fuel storage areas and supply systems; hangars for maintenance, repair and overhaul; facilities for general aviation aircraft; facilities for helicopters; and the control tower and communications system.

NEWARK AIRPORT TODAY

Newark Airport lies on 2300 acres of partially reclaimed meadow-marsh. Its immediate physical bounds are the New Jersey Turnpike on the east, U. S. 1 and Port Street on the north, U. S. 1 and Humboldt Avenue on the west, and North Avenue on the south. Additional land area for airport use is not readily available. Consequently, any proposed plan for the expansion of this airport should be confined as much as possible to its present boundaries. Where necessary to achieve the desired results, however, some real estate or easement, or both, may be needed for approach lighting or a runway extension.

On this site there are now two active runways—the 7000-foot instrument runway, 4-22, and the 6880-foot cross-wind runway, 11-29. The passenger terminal and parking area are in the northeast corner of the airport, adjacent to Port Street. Further west, along the south side of U. S. 1, is a new cargo terminal area comprising four buildings. West of these is the new United Air Lines hangar. Between the cargo terminal complex and the passenger terminal building are a larger hangar, used for maintenance by a number of scheduled airlines, and a smaller one, which is occupied by Newark Air Service.

Runway 4-22 is one of the finest instrument runways in the country. Completed in 1952 at a cost of $9,000,000, it is equipped at both ends with an instrument landing system and with 3000-foot long high intensity approach lighting along the extended centerline of runway. The high-intensity approach lighting lamps are discharged sequentially to point out brilliantly the way to the runway in the poorest weather. Closely-spaced, elevated lights mark the edges of the runway. Transmissometer and ceilometer equipment measure the ceiling and visibility at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DIVISION ST.
HUMBOLDT AVE.
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1000
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CONTROL TOWER
PRESENT PLAN
NEWARK AIRPORT
NEW JERSEY TURNPIKE

the approach end and these data are automatically relayed to the control tower.

The control tower is a 165-foot-high structure located 1300 feet south of Runway 11-29 and 1900 feet west of Runway 4-22. Completed at a cost of $1,750,000 in 1959, it gives the controllers a high-angle, unobstructed view of the critical areas on the airport.

The airport surface is practically flat, varying from an elevation of 10 feet around the boundaries to a maximum of about 20 feet above mean sea level. The runway surfaces vary from Elevation 7 to Elevation 18.

At present, obstructions to flight are few. The presence of some masts in the channel of Port Newark has caused the Runway 29 threshold to be displaced, and the effective length of this runway is now about 6000 feet. Stacks and other obstacles at the west end of this runway impair somewhat operations at the opposite end. Arrangements being made with Port Newark to vacate certain ship berths will shortly result in a gain of about 400 feet of runway length.

Approach and takeoff paths in the other two directions are clear for the runways at their present lengths. Any substantial lengthening to the south of Runway 4-22 must take into account the height of the North Avenue embankment at the approach to its crossing over the New Jersey Turnpike. Similarly, an extension of this runway to the north would require the investigation of possible conflicts with the ramps of the Turnpike interchange and the two-story toll plaza building. As for Runway 11-29, its extension to the west would encounter U. S. 1 as it now exists.

The Port of New York Authority considers the maximum capacity during instrument weather of the existing single-instrument-runway airport presently to be 31 aircraft operations per hour.

Developments in equipment and procedures for controlling air traffic will probably make possible an increase of the capacity of a single instrument runway. When such equipment and procedures become operational and are placed in service, it is reasonable to expect that Newark Airport as it exists today could achieve a capacity in instrument weather of as much as 35 operations per hour. This represents, we believe, essentially the maximum capacity which can be hoped for in the coming decade if the runway system at Newark Airport remains unchanged.

Since the weather conditions at Newark Airport are such that pilots must make their approaches into the airport by instruments between 15 and 20 per cent of the time, and since schedule dependability is essential to orderly airline operations, the air carrier schedules are based to some degree upon the airport capacity during instrument weather. During good weather, when aircraft can operate under visual conditions, a smaller interval between aircraft operations can be safely used and the airport capacity is considerably greater.

We have reviewed the orientation of the runways with respect to their alignment with winds from the different directions. Taking the strengths of these winds and the percentage of time from each direction into account, it is our conclusion that the present runway headings are adequate for future operation of the airport.

The noise abatement procedures adopted at Newark Airport have generally proved to be relatively successful in combination with the use of the following designated preferential runways:

	PRIORITY		
	First	*Second*	*Third*
TAKEOFF RUNWAY	11 or 4	22	29
LANDING RUNWAY	29 or 22	4	11

Aircraft taking off on Runway 4 make a 20-degree right turn as soon as it is practicable to avoid the Ironbound section of Newark. Pilots taking off on Runway 22 make a 30-degree left turn, avoiding the residential areas in Elizabeth. The climb-out rates and power settings are varied to suit the aircraft, its load, wind conditions, and other factors; the goal is to create the lowest possible intensity of noise below the flight path.

The Port of New York Authority has adopted 112 PNdb as the maximum level of sound pressure which jet operations are permitted to make over residential areas. This has resulted at times in stiff operating penalties for the early jet models introduced in 1958. However, the jet-equipped operators have compiled an excellent record of compliance with the procedures set up by the Port Authority.

Since the introduction of jet aircraft, industry has spent, and continues to spend, vast amounts to improve the efficiency of their power plants. From this intensive research program, the turbofan engine has emerged. Not only is it a more efficient engine than the turbojet, it is also quieter at equivalent gross takeoff weights.

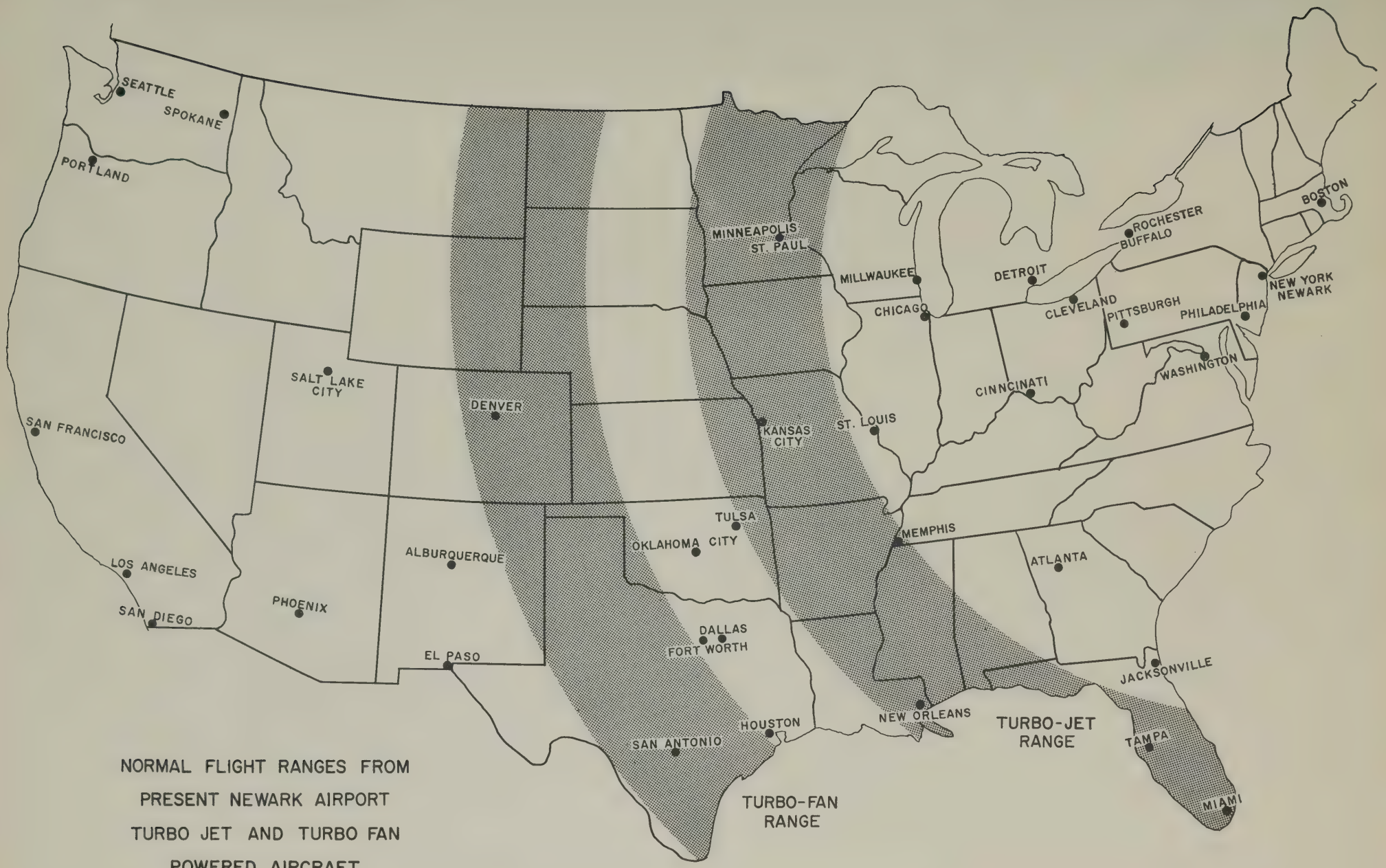
As a result, some of the airlines are replacing their turbojet engines with turbofans, and the jet fleet of one is now 100 per cent turbofan-equipped. All new jet aircraft now being built will be equipped with the more powerful turbofan engines. During the coming years, therefore, an increasing proportion of our jet fleet will be so powered, and generally lower noise levels adjacent to the airport should be achieved. While noise from some of the longest-range takeoffs by fan-powered aircraft may approach or equal the noise of straight jets operating over shorter distances, it can be anticipated that the general noise situation will improve. The latest development to diminish jet noise output involves an internal change in the engine using what is commonly referred to as a "hush kit." Installation of the hush kit results in a reduction of the high-pitched whine sound that comes from the front of the engine and is most noticeable when an aircraft approaches for a landing with reduced engine

power. Without the noise of the jet exhaust to hide it, the whine, which is caused by the compressors, is quite apparent. While the hush kit does not reduce the peak noise of the compressor whine very much, it tends to make this noise more directional. Thus, for those on the ground, the length of time during which the maximum levels of sound pressure are perceived is sharply reduced.

Undoubtedly, much of the annoyance caused by landing jets flying over residential areas stems from the length of time during which the peak level is heard. From tests conducted with unhushed engines, the peak level of sound pressure may persist for as long as *four* seconds. Hushed engines, on the other hand, transmit their peak noise to the ground only for a duration of about *one* second.

Some have expressed the belief that engine manufacturers may be approaching the point of diminishing returns in their efforts to reduce the noise made by jet engines. Although their efforts toward noise reduction are continuing, the next major advance may well have to come from the airframe manufacturers, who are presently working on high-lift wing devices to shorten takeoff lengths and improve aircraft climb ability. If they are successful, and there is reason to believe they may be (given time and sufficient money), it may eventually be possible for future aircraft to take off at lower speeds in somewhat shorter distances and climb out on steeper gradients, thereby further ameliorating the noise problem.

The map on the following page shows the approximate present-day ranges of economic non-stop jet operations from Newark Airport. Assuming profitable payloads, the inner arc is about the limit for turbojet equipment and the outer arc the limit for turbofans. Therefore, until runways are lengthened at Newark Airport, passengers from Northern New Jersey who wish to fly to Los Angeles and San Francisco will probably continue to find a change of planes at Chicago necessary, unless they depart from New York International Airport.



NORMAL FLIGHT RANGES FROM
PRESENT NEWARK AIRPORT
TURBO JET AND TURBO FAN
POWERED AIRCRAFT

THE NATURE OF FUTURE OPERATIONS

RUNWAY LENGTHS

There are ten major domestic destinations for passengers flying from New York. Five of these are in the less-than-500-mile range—Boston, Washington, Buffalo, Cleveland and Pittsburgh; three are in the 500-to-1100-mile range—Detroit, Chicago, and Miami. The other two—Los Angeles and San Francisco—are 2,475 and 2,580 miles, respectively, from New York.

In the New York-New Jersey metropolitan area, the current demand for non-stop transcontinental service may be gauged from the fact that in the Official Airline Guide of November 15, 1961, there were listed a total of 20 daily non-stop flights to the two major West Coast destinations. Such service, if it were to become available at Newark Airport, would divert some patrons from New York International Airport, would attract a proportion of those making use of airline transportation to the West Coast for the first time, and would generate new demand among people who would not make use of the service unless it were available specifically at Newark Airport.

Since it is unlikely that major advances in high-lift wing techniques will be widely incorporated into the fleets of the trunk airlines before the early 1970's, runway length requirements for the next 8 to 10 years will remain substantially as they are today. Therefore, if the goal of expanding Newark Airport is to provide a facility which can handle transcontinental non-stops, at least one runway having a minimum length of 9500 or 10,000 feet will be required.

ADDITIONAL RUNWAYS

The single and most fundamental requirement, if Newark Airport is to be developed to provide greater service, is the construction of one or more additional runways. The number and location of runways on Newark Airport will be the most important factor in determining to just what extent Newark Airport and its service to New Jersey can grow.

At the present time, a fully developed airport is commonly considered to be one having two pairs of widely separated parallel runways, one pair oriented with the prevailing winds, the other pair being more or less at right angles to the first pair. The wide separation permits takeoffs on one runway and landings on the other to be conducted independently.

Where parallel runways are not widely separated, or where runways in use intersect, or where their projected centerlines intersect, aircraft operations on the two runways are interdependent and a takeoff on one must wait until the landing on the other has been essentially completed. This time which must be spent in waiting reduces the capacity of an airport.

At Newark, the size of the airport is adequate for a partial development. It is also close enough to being adequate for an essentially full development to require that this possibility be fully studied. Barriers of industrial and other land uses presently provide minimum separation to residential areas of 2.7 miles from the nearest point of start of takeoff and 1.4 miles from any landing runway threshold. By comparison with some major airports in the country, these conditions may be considered favorable for airport development.

In planning a new runway or runways, nothing could be more important to Newark's continuing service to the area than

for the plans to make ample provision for future runway length requirements. The longest range non-stop jet flight from Newark is now 1100 miles to Miami. The longest range non-stop piston engine aircraft flight, an all cargo flight, is 1380 miles to Dallas, Texas. All of the rest of Newark's non-stop service area lies within this range. No non-stop service to the west coast has ever been provided because the runways are not long enough.

Unless at least one of Newark's runways is made long enough or is planned for extension to sufficient length, Newark will continue to be only a short- and medium-range airport and will not completely fulfill its potential for New Jersey. While we cannot foresee the longer-range future in accurate detail, we believe that for best service through this decade at least one runway should be planned for a length of approximately 10,000 feet.

FREQUENCY OF OPERATIONS

At Newark Airport, as at most other airports, the hourly rate at which arriving and departing aircraft desire to operate on the runways (demand) varies with visibility and ceiling, the time of day, and, to a lesser extent, on the day of the week and the month of the year.

While scheduled airline operations may be carried on independently of most weather conditions, visibility and ceilings have a marked effect on the level of general aviation activity. Thus, with good visibility and high ceilings, when most aircraft in the airport terminal area are operating under Visual Flight Rules (VFR), the demand for use of the runways at Newark Airport is significantly higher than it is during the corresponding hour on days of poor visibility and low ceilings, when aircraft are operating under Instrument Flight Rules (IFR). The higher the seasonal fraction of general aviation aircraft is, the greater will be the difference between the peak-hour VFR demand and the peak-hour IFR demand.

The fluctuation in demand from hour to hour during the day shows two busy periods—one occurring in the pre-business hours of the morning and one in the late afternoon from about 4:00 pm to 6:30 pm. Among these four or five busy-hours, one sixty-minute period will show the greatest demand and be called the peak-hour. Depending primarily on the level of general aviation demand, this period usually occurs among the late afternoon busy-hours.

For Newark Airport, the average of the daily peak-hour demands during all the IFR weather experienced during the year would represent the desirable design figure for IFR capacity. However, the question is probably moot, since demand in the Metropolitan Area will soon exceed capacity.

The cumulative evidence of studies performed to date on present and future air traffic demand at the Port Authority airports demonstrates that the combined IFR capacity of the three airline airports as they exist today will be fully utilized by the average daily peak-hour IFR traffic demand well before 1965. Any reasonable expansion of Newark Airport, therefore, can be justified if the capacity will be substantially increased by the new facilities.

NOISE AND ITS ABATEMENT

The residential neighborhoods that are generally affected by the noise problem lie in the Weequahic and Ironbound sections of Newark, in Hillside, and in the Elizabethport section of Elizabeth.

The Port Authority's established criterion of 112 PNdb for maximum permissible jet takeoff noise at New York International Airport appears to the Federal Aviation Agency as ". . . a reasonable compromise in resolving the conflict of interest between aircraft operators and

property owners presently residing in or planning to locate in the approach and takeoff paths of jet airports."*

The maximum limit of 112 Perceived Noise decibels would not be reached in any of the above areas by the great majority of year-around operations. However, in instrument weather, it would usually be necessary for approaching aircraft to come straight in all the way on the approach to Runway 4 or Runway 22. On a few days each year, strong winds from the east will make landings necessary on Runway 11. Depending upon the airport development plan adopted, such operations conducted by four-engine jets could result, within comparatively narrow corridors over residential areas, of noise levels exceeding the Port Authority's limit.

With the proper procedural turns being made, noise caused by takeoffs would very rarely, if ever, exceed 112 PNdb in either the Ironbound section or Elizabeth. On takeoffs from Runway 22, a procedural turn to the left would bring aircraft into a path directly over the Lehigh Valley tracks. This takeoff would cause higher noise levels within Weequahic Park and could place a thin residential strip just west of Elizabeth Avenue on the fringe of the 112 PNdb noise level contour for a small proportion of takeoff operations. Since Runway 29 would have the lowest priority for takeoffs in any runway configuration, it would be used only when winds of 16 knots or over were blowing from the west. Such winds enable the aircraft to get off the runway sooner and climb more quickly. They also cut down on the noise received in the Elizabeth Avenue area from noise sources to the east.

A fuller treatment of the noise conditions that would be encountered is contained in the comparison of the various plans investigated.

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*_Aircraft Noise Abatement_, Planning Series Item No. 3, Federal Aviation Agency, Airport Planning Branch, Airports Division, Bureau of Facilities and Material, Sept. 2, 1960.

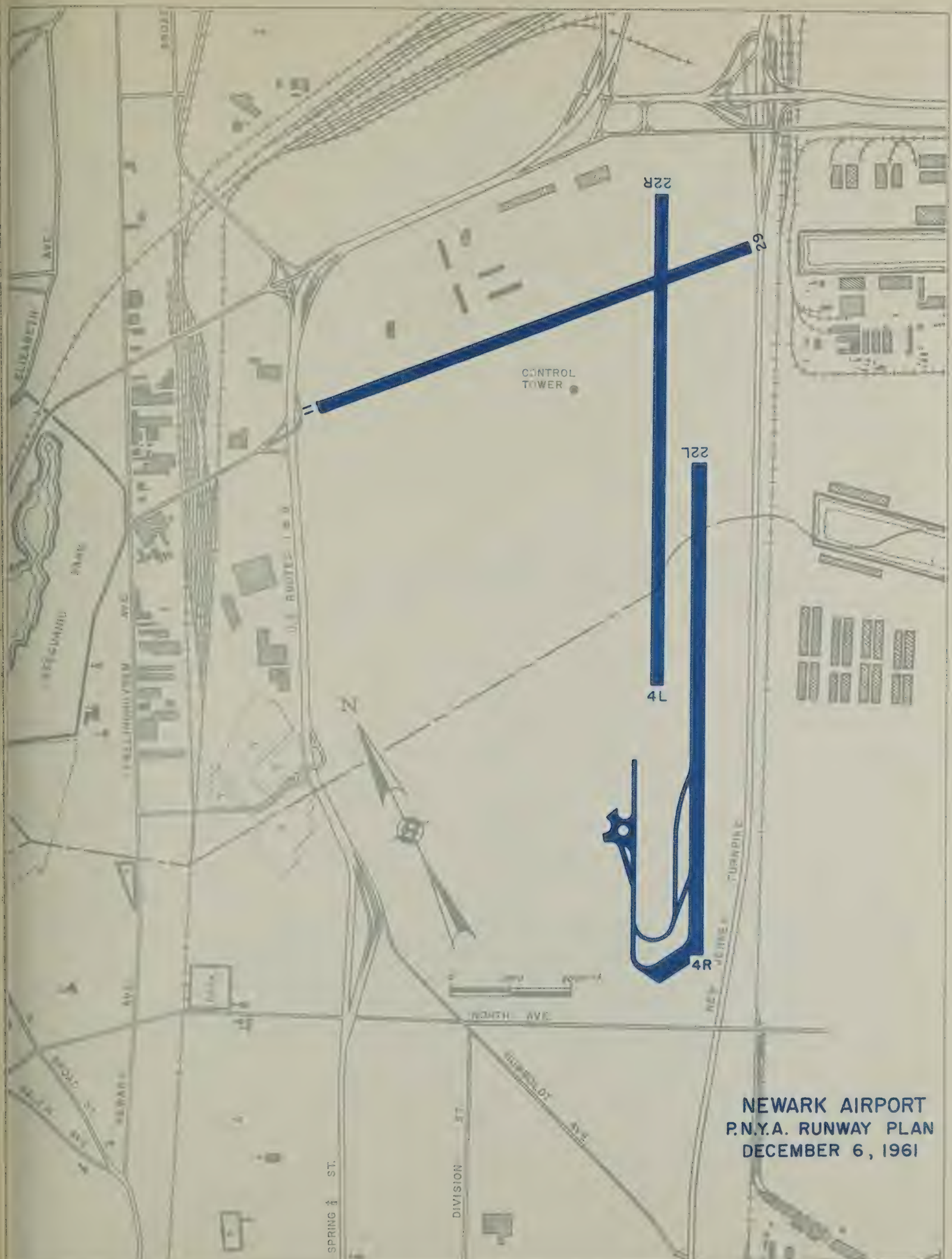
STUDIES OF AN EXPANDED NEWARK AIRPORT

As indicated elsewhere herein, Newark Airport is today entirely a short- and medium-range facility. Even with new long runways for transcontinental flights, we believe that providing short- and medium-range service will continue to be its primary function. As a matter of sound business and economic operation, it may be anticipated that of the large, four-engine, jet aircraft operating out of Newark very few would be on long-range flights, operating at or near full gross weights. The great majority of such aircraft would be operated under moderate loads. Consequently, relatively few takeoffs will require the full main runway lengths shown in the accompanying plans. As an aid in understanding this, the plans indicate by means of identified arrows that the normal takeoff would be actually made by the time the middle of the runway length is reached or slightly later. This would be true for all two- and three-engine jets and for nearly all of the four-engine jets.

The goals aimed at in each of our studies follow from the requirements heretofore noted: i.e., contained noise, runway lengths required for scheduled transcontinental non-stop operations, and increased capacity of the airport during instrument weather. Because of the primacy of these requirements and the limited time allotted for study, terminal and hangar area needs, taxiway layouts, fuel storage and supply, and highway access were given only brief attention. The criterion used for such items was to allow adequate space for the development of these facilities outside of the space required for runway clearances. For each of the basic designs presented below, we believe that this criterion can be satisfactorily met, although the amount and distribution of available space varies from one design to another.

PORT AUTHORITY PLAN

The plan made public on December 6, 1961, by the Port of New York Authority would provide an airport of increased capacity but one limited to medium-range aircraft, based upon today's equipment. We are in agreement with the Port Authority's estimate that such construction would permit an increase in IFR capacity of 50 per cent over that being obtained today. The potential non-stop range of departing aircraft would be increased, but not sufficiently to permit non-stop flight from Newark Airport to destinations on the West Coast.



NEWARK AIRPORT
P.N.Y.A. RUNWAY PLAN
DECEMBER 6, 1961

PLAN A

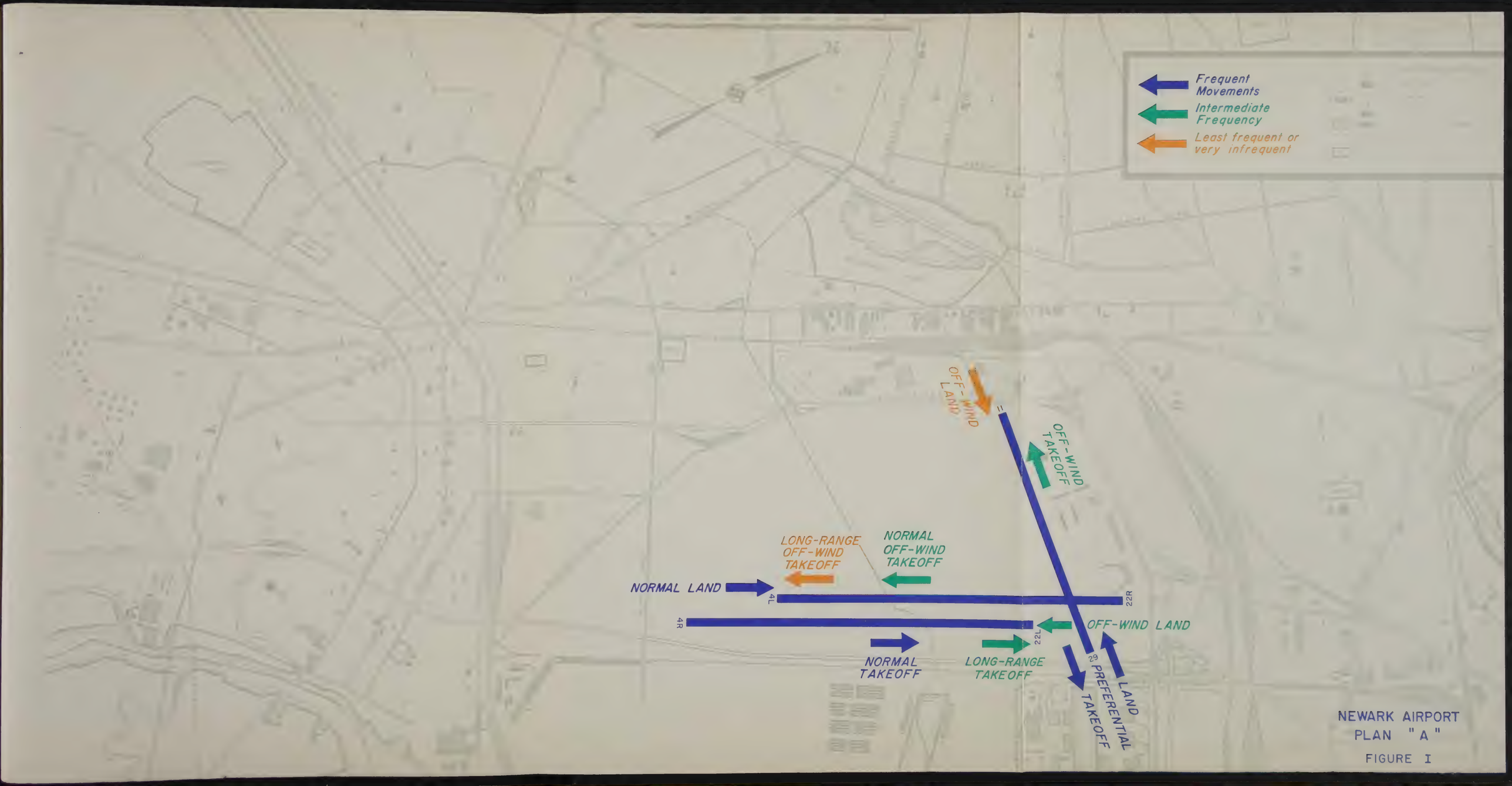
This plan is almost identical with that made public by the Port of New York Authority on December 6, 1961, except for runway lengths. Both call for an additional instrument runway, 4-22. The new runway, offset 2600 feet to the north of 4R-22L, would be designated 4L-22R. The entire 3000 feet of runway added to 4R-22L is at the south end of the present 7000-foot runway. About 520 feet of length has been added at the west end of Runway 11-29, which would make it 7400 feet long. This added length would mainly benefit operations on the preferential runway, i.e., takeoffs toward and landings from the east. Such improvement to the preferential runway would slightly reduce the proportion of operations on the other runways.

The arrows on Figure 1 show the way normal operations would be conducted, and the table below shows the preferential system which would be employed.

	PRIORITY			
	First	*Second*	*Third*	*Fourth*
TAKEOFF RUNWAY	11*	4R	22R	29
LANDING RUNWAY	29	22L	4L	11

*except for non-stop West Coast flights, use 4R or 22R.

Non-Stop Range This arrangement of runways would provide the carriers with a facility from which non-stop transcontinental takeoff operations could be made about 85 per cent of the time. During periods when wind conditions would make the use of Runway 11-29 mandatory, it might be necessary to schedule intermediate fuel stops for such flights.



NEWARK AIRPORT
PLAN "A"

FIGURE I

IFR Capacity Operations into winds from the north would be conducted with takeoffs on 4R and landings on 4L; operations into winds from the south would be conducted with takeoffs on 22R and landings on 22L. In the first case, delays would occur because of the need for taxi clearance to departing aircraft crossing the approach path of landing aircraft. In the second case, delay would result from the interruptions to takeoffs from aircraft taxiing from their landings to the terminal. In our estimate, this kind of operation would permit an IFR capacity increase of approximately 30 to 40 per cent over that of the present single instrument runway.

PLAN A_1

Plan A, just outlined, could also be drawn up to limit Runway 4L-22R to a maximum length of 8000 feet. For purposes of reference this will be known as Plan A_1. Plan A_1 also would be quite similar to the Port Authority's Plan, except that Runway 4R-22L of Plan A_1 is 10,000 feet long, rather than 8000 feet as shown by the Port Authority. The thresholds of the two parallel runways of Plan A_1 are displaced 4400 feet.

Non-Stop Range Plan A_1 would probably be the more desirable configuration because the operation of large jet carriers requiring a long runway for takeoff should be sufficiently infrequent that their takeoffs could be interspersed with landings on 4R or 22L, which would be 10,000 feet long, as in Plan A.

IFR Capacity Plan A_1 would eliminate delays at the end of 4L to aircraft taxiing out for takeoff on 4R. With the 4L threshold 4600 feet upwind from the beginning of Runway 4R, the height above ground of the 50-to-1 slope of the Runway 4L clearance plane would be 88 feet at the line of crossing, and clearance to a 3-degree glide slope would be almost 300 feet. With such margins, aircraft could be permitted to make uncontrolled crossings of the extended 4L centerline to reach 4R for takoff. As a result, the IFR capacity could be increased by about 50 per cent over the capacity of a single instrument runway.

Under this plan, with the wind from the south, it would be necessary to have long-range takeoffs made on the longer runway, 22L. Such takeoffs would be mixed with the routine landings on 22L. While this would interfere to some extent with airport capacity, the effect should be slight because of the limited number of long-range takeoffs.

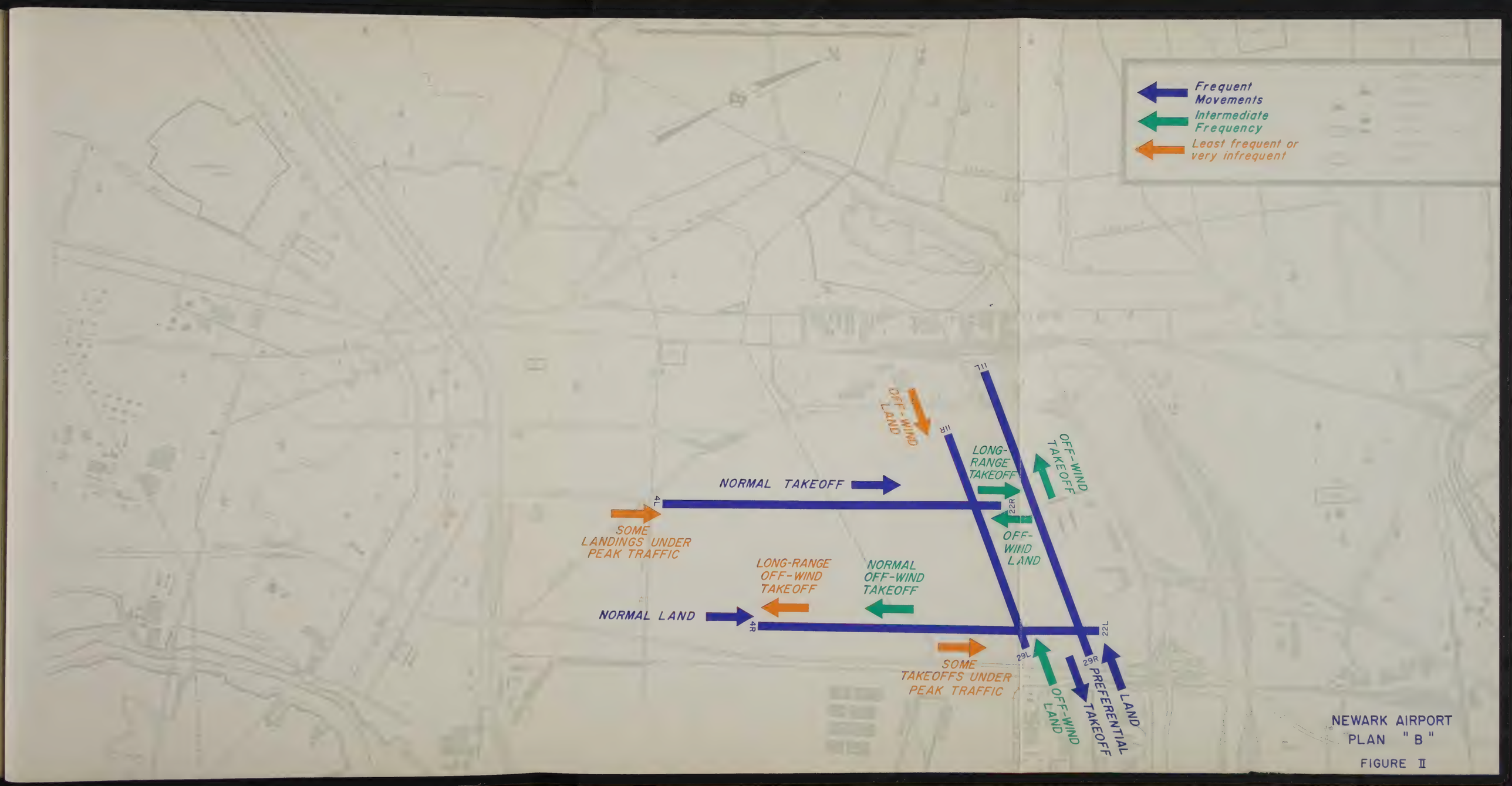
PLAN B

A transcontinental, high-capacity facility would require those elements shown in Figure II. The runway system comprises two instrument runways separated by approximately 3500 feet and two cross-wind runways separated by approximately 1500 feet. Existing Runway 4-22 is retained and redesignated 4R-22L. Its 10,000-foot length is attained by adding 1000 feet of runway to the south and 2000 feet to the north. The new runway, 4L-22R, starts just north of the North Avenue-Humboldt Avenue intersection near the airport's southern boundary, giving it an offset with respect to 4R-22L of about 3000 feet.

In such a configuration, the open parallel runways can be operated independently in IFR weather; that is, one can handle landings while the other handles takeoffs. During those VFR peak-hours when landings predominate over takeoffs and exceed the VFR acceptance rate of the normal landing runway, the runways could be coordinated to increase capacity still further by interspersing some landings on the takeoff runway. The reverse procedure could be used if the number of aircraft awaiting takeoff were to exceed the capacity of one runway. It should be noted that simultaneous landings on two runways would occur only when the VFR capacity of the normal landing runway, which is well in excess of its IFR capacity, were exceeded by the demand.

The increase in the number of operations at such times would result largely from added numbers of small, single-engine, general aviation aircraft. For maximum traffic efficiency, these aircraft, which are the slowest and quietest, would be the ones normally instructed to use the takeoff runway.

The existing Runway 11-29, redesignated 11L-29R, is shown extended across U. S. 1 with a total length of 8800 feet. It is paired with a new, shorter parallel runway, 11R-29L. Since this new runway, shown 6600 feet long, would be used primarily for landings, it would not be necessary for both cross-wind runways to be of equal length.



NEWARK AIRPORT
PLAN "B"

FIGURE II

The use of such a system of runways would be based on the following table of preferences:

	PRIORITY			
	First	*Second*	*Third*	*Fourth*
TAKEOFF RUNWAY	11L*	4L	22L	29R
LANDING RUNWAY	29R, 29L	4R	22R	11R

*except for non-stop West Coast flights, use 4L or 22L.

Non-Stop Range The non-stop range capability of this configuration is basically the same as that of Plan A. The length added to 11L-29R would primarily benefit takeoffs to the east. It would not necessarily be sufficient always to permit a full revenue load to be carried non-stop to the West Coast, except with a stiff takeoff headwind. It would, however, reduce the need for fuel stops on such flights to an absolute minimum from Newark Airport. As the performance of jet aircraft is improved to the point where transcontinental non-stop flights can be made from runways of this length, it would contribute greatly to noise abatement if as many flights of this kind as possible were able to head out over Newark Bay on takeoff. The added length at the west end of the runway and the substantial cost of crossing over U. S. 1 could possibly be justified on such a basis.

IFR Capacity The widely separated dual runways, with simplified taxiing from a central terminal, would approximately double the IFR capacity of the present-day facility.

PLAN C

The open V type of plan was investigated to determine the worth of a runway system which would provide short, direct taxiing distances from a central terminal building without at the same time creating flight paths over additional sections of Elizabeth. As in each of the other basic plans, there is a pair of 10,000-foot long instrument runways, one of which represents a lengthening of existing Runway 4-22. The new instrument runway in this plan would be designated Runway 1-19.

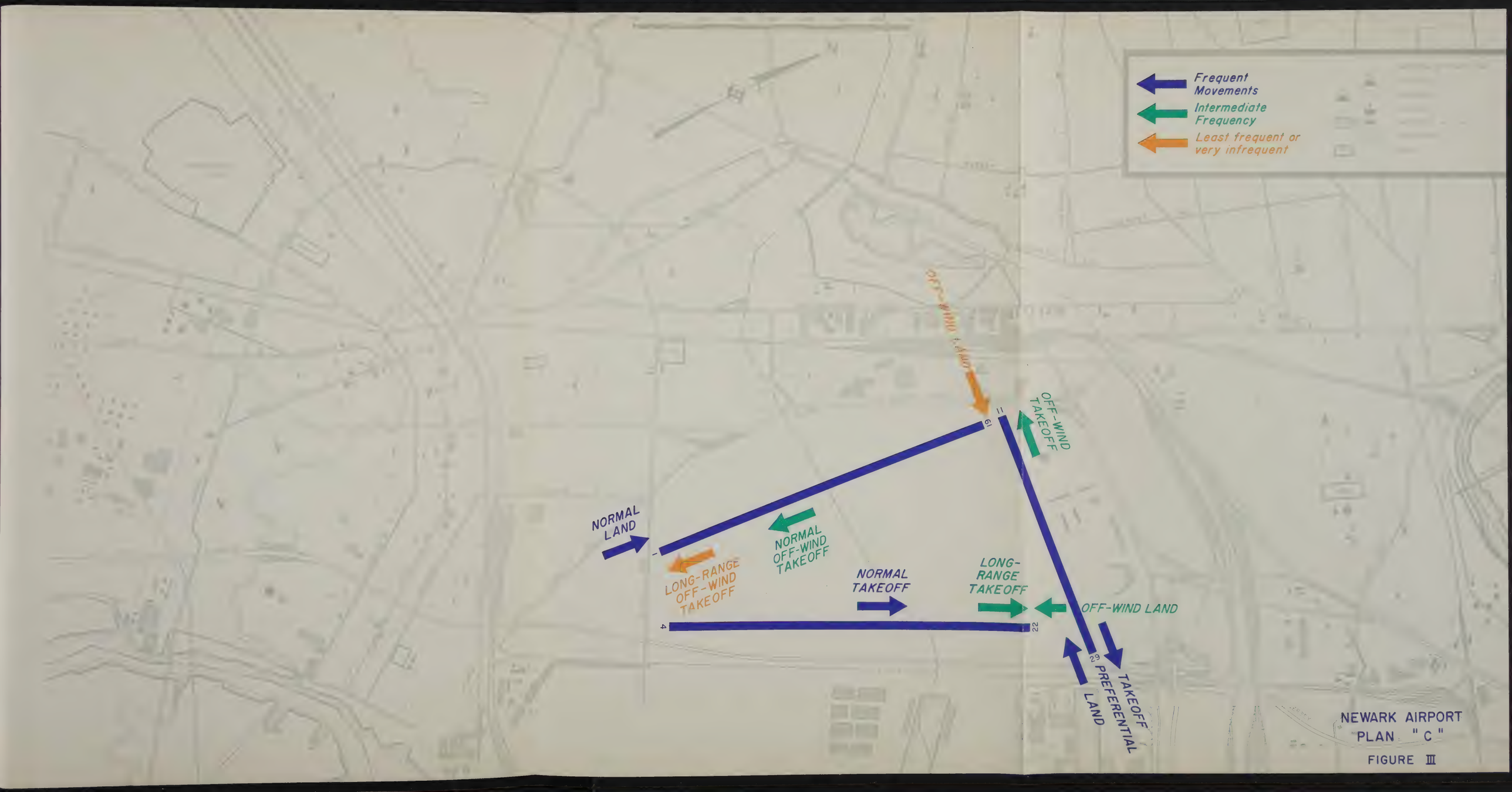
The southern end of each new instrument runways lies just north of North Avenue. If it should be anticipated that the full length of Runway 1-19 would ultimately be required, then its profile should be planned so that landings and takeoffs over North Avenue would clear vehicular traffic.

The table of preferential operations on this runway system would be as follows:

	PRIORITY			
	First	*Second*	*Third*	*Fourth*
TAKEOFF RUNWAY	11*	4, 19	22	29
LANDING RUNWAY	29	1, 22	4	11, 19

*except non-stop West Coast flights, use 4 or 19.

Non-Stop Range One advantage of this system is that a greater wind coverage would be obtained. The per cent of operations which would have to be performed on Runway 11-29 would drop, and the use of Runways 4, 22, and 19 would cover all but about 8 per cent of conditions.



NEWARK AIRPORT
PLAN "C"

FIGURE III

IFR Capacity When takeoffs can be conducted on Runway 4 while landings are being made on Runway 1, the diverging configuration of the runways would result in an IFR capacity essentially equivalent to that of the independent open parallel system of Plan B. The two runways could be operated independently because takeoffs from Runway 4 would be adequately separated from aircraft executing the missed approach procedure on Runway 1.

However, when the wind is from the south and takeoffs are being conducted from Runway 19 with landings on Runway 22, the possibility of conflicting aircraft paths in the event of a missed approach requires that the runways be operated interdependently.

It should be noted that approach conditions and equipment at Newark are about the best in the country, with the result that missed approaches are very rare. We are advised by tower controllers that only about twice a year is it necessary for any reason for a pilot to apply power to his engines and go around for a second landing approach.

The capacity of such a system will be very sensitive to the criterion used by air traffic controllers for determining the point along the landing path of an arrival on Runway 22 when it is safe for a departing aircraft on Runway 19 to begin its takeoff roll.

The maximum IFR capacity which could be achieved with the converging runways would represent an increase of approximately 50 per cent over that of today's single runway.

Instrument Approach to Runway 1 At the present time, all of the instrument approach runways at the three metropolitan airline airports are oriented in a northeast-southwest direction on magnetic compass headings of approximately 40 and 220 degrees. Having these runways parallel has been a valuable aid to the air traffic control of arriving

aircraft, particularly during instrument weather since, in terms of airspace requirements, the metropolitan airports are relatively quite close together.

If an instrument approach on a heading of 10 degrees were to be provided to an essentially north-south runway at Newark Airport, aircraft entering their approach to this runway some eight to ten miles south of the airport would be operating in what is now an unused buffer zone, over Staten Island, that separates the Newark and LaGuardia approach corridors.

A rearrangement of approach airspace on this account would, therefore, be required. The fact that this would present problems would not necessarily eliminate Plan C from further consideration. Airspace allocations are constantly being revised for various reasons and, if Plan C were considered to have sufficient merit, this would be ample reason to determine the feasibility of such an airspace change.

COMPARISON OF PLANS

STAGE CONSTRUCTION

Before entering into comparisons of the advantages and disadvantages of the various plans which have been examined, it would be well to emphasize that each, with the exception of the Port Authority's plan, is adaptable to stage construction. Although we are satisfied that the full length of a 10,000-foot-long runway would be taken advantage of if it were available at Newark Airport today, we are aware that the construction of such a runway or runways may depend on many factors, including those of economy and degree of need.

Plan A could be developed in three stages, beginning with the plan of the Port Authority, then progressing to Plan A_1, and later, possibly, to Plan A. Initially, the Port Authority's plan would improve the position of the communities relative to aircraft approaching and taking off because operations would be moved about 1800 feet farther south of Newark and 1600 feet farther north of Elizabeth. The existing 1800 feet on the north end of Runway 4R-22L would be retained, although high-intensity approach lighting would be installed in the present pavement area.

Development of the second stage (Plan A_1) would simply require returning to service the 1800-foot length of runway on the north end of 4R-22L and adding a 200-foot extension at the south end. This would mean the return of aircraft landing into winds from the south to altitudes currently being used over Newark.

If the final stage were to be used, it would be necessary to add 2000 feet of runway to the south end of Runway 4L-22R to obtain

the 10,000-foot dual runway system. Long-range takeoffs to the south could then be shifted to Runway 22R.

The final stage of the sequence just described would result in a 2600-foot offset between runway ends. The problem of taxiing between the terminal and Runway 4R-22L might dictate an extension of the taxiway route to the vicinity of North Avenue. Aircraft crossing the extended centerline of Runway 4L would do so at a distance of approximately 3400 feet from the threshold of Runway 4L, where the approach surface is 65 feet above the elevation of the threshold and clearance to the 3-degree glide path is over 140 feet. Unless the FAA, the airlines, and the pilots concur on the adequacy of such a margin, the extended taxiway would not be feasible and capacity would be adversely affected at this stage, as previously mentioned.

Plan B would probably begin with Runway 4R-22L being the major runway for both landings and takeoffs by carrier aircraft operating in both directions. Runway 4L-22R at an initial length of perhaps 5000 feet would be used primarily by general aviation aircraft to relieve the main runway load.

A second stage for Plan B might be extension of Runway 4L-22R to 7000 or 8000 feet in order to handle medium- and short-range carrier takeoffs to the north, independent of carrier landings from the south. Carrier landings from the north would be made on this runway except during light traffic periods.

The addition of the second east-west runway, 11R-29L, might come either before or after the lengthening of Runway 4L-22R.

The third stage, extension of Runway 11L-29R west over Route U. S. 1 and of Runway 4L-22R to its ultimate length of approximately 10,000 feet, would be undertaken only to achieve the maximum capacity and efficiency of the airport.

Plan C would almost surely begin with Runway 1-19 being constructed to a length of 7000 to 8000 feet. The airport, so developed, would be used in the manner previously described except that long-range takeoffs to the south would be made on Runway 4-22.

The lengthening of Runway 1-19 to 9000 or 10,000 feet would be an ultimate development to secure maximum capacity of the airport.

Conceivably, the ultimate development of Plan C could include an additional east-west runway, such as 11R-29L as shown in Plan B, to maintain maximum capacity during strong cross-wind conditions.

RELATIVE NOISE LEVELS

Takeoffs Under all plans, by the use of procedure turns, noise on takeoffs to the south can be kept below the 112 PNdb level in the Elizabethport and Ironbound sections. On takeoffs to the west, unless restricted by noise-abatement regulations, large transcontinental four-engine jet so loaded as to make full use of the effective length of Runway 29 on takeoff would occasionally cause the 112 PNdb level to be reached in a narrow residential strip along Elizabeth Avenue in the Weequahic section and in Hillside. If Runway 11L-29R were to be extended as shown in Plan B, aircraft taking off to the west would not normally benefit from the extension because noise-abatement restrictions would require that the actual lift-off take place well to the east of U. S. 1 in any case. The extension would represent an added safety factor, however, should it be necessary to discontinue a takeoff because of an aircraft malfunction.

Under any plan, takeoffs to the north would use the present runway and follow the present anti-noise procedures, which are quite effective in minimizing noise levels in the Ironbound section.

Landings Under Plan B, a few occasional landings from the west on the short cross-wind runway, 11R, might cause some noise at or slightly above 112 PNdb in Hillside, near the county border west of the park.

Landings from the west under any of the other plans would affect an area about 1500 feet farther north in Newark, along the present runway centerline. The affected area would be slightly larger in size, since the terrain is somewhat higher. It should be recalled that landings from the west are necessary only about 2 per cent of the time. At the time of this writing, no large jets have landed from the west; consequently there is no experience with actual sound pressure levels.

Landings from the south would affect Elizabeth in various ways. The Port Authority's plan does the most to reduce the noise perceived in this section. In Elizabeth, a small area equal to about three city blocks may occasionally experience noise at 112 PNdb from such aircraft coming in to Runway 4R-22L on a 3-degree glide slope.

A lengthening of Runway 4R-22L to 9000 or 10,000 feet to achieve transcontinental range capability (Plan A_1), would not alter the levels of noise caused by approaches over Elizabeth.

The effect in Elizabeth of lengthening Runway 4L-22R of Plan A to its full 10,000 feet would be to increase the penetration of landing noise to the extent that 112 PNdb might be produced by four-engine jets at points as far south as the New Jersey Turnpike. The affected area would not be wide, however, and about half of it would be occupied by industrial blocks, the railroad, and the Turnpike right-of-way.

The construction of the runway system shown in Plan B would require aircraft landing from the south to use Runway 4R. We estimate that the noise created by four-engine jets making instrument approaches to this runway would penetrate at the 112-PNdb-level to distances of 3000 or 4000 feet south of Trumbull Street. The axis of penetration

would lie on the Turnpike at Trumbull Street and pass about a block west of Jackson Park and St. Patrick's School. The noise levels perceived within the affected area would exceed the 112 PNdb limit only very slightly.

During those busy VFR hours when arrivals exceed departures, Runway 4L would handle some approaches in addition to its takeoffs. By proper sequencing, the capacity of the airport can thus be improved for VFR operation, when the level of activity is considerably greater than during instrument weather. However, it is anticipated that all jet and carrier operations would be segregated to Runway 4R. With only piston aircraft being allowed to approach over Elizabeth, these aircraft, the smaller business and executive types, should cause no particular noise problem in Elizabeth.

Under Plan C, approaches from the south to Runway 1 made by four-engine jets coming in on instruments would cause noise levels of 112 PNdb as far south as Arthur Kill, and levels of 113 or 114 PNdb might be experienced in the vicinity of Trumbull Street. This flight path would follow a different route from the one which now leads to Runway 4 and would be over a more densely populated area.

In the Ironbound section, noise caused by four-engine jets approaching Runway 22L from the north to the runway configuration proposed by the Port Authority should never exceed 112 PNdb in residential areas. Expansion of this runway system to that proposed in Plans A_1 and A would merely mean the return to service of the northern 1800 feet of the present Runway 4-22. Consequently, the landing noise levels in the Ironbound area under Plan A would be no higher than they are today.

With the runway system proposed in Plan B, the normal approach from the north would be to Runway 22R, over the Ironbound section. The instrument approaches made by large equipment to this runway would result in noise levels on the ground at or slightly above 112 PNdb for a distance of about 4000 feet north of the Pennsylvania tracks. Occasionally, approaches to the south during those peak hours when arrivals

exceed departures would require the use of Runway 22L, and some noise at the level set by the PNYA might be experienced as far north as Wilson Avenue. The approach path to this runway, however, would follow a slightly curved path, staying east of Route U. S. 1, as aircraft now do under fair weather conditions.

Approaches from the north to Runway 4-22 of Plan C should in no case cause levels of noise above the 112 PNdb limit in residential areas of the Ironbound section.

AIRPORT CAPACITY

Each of the five plans examined would offer a substantial increase in both the IFR and VFR operating capacities of Newark Airport.

For year-around IFR operations, the choice with respect to capacity between Plans A and C would require a detailed study and analysis. When operations are being conducted to the south, the criterion for releasing departures following arrivals on the converging V layout of Plan C would probably result in a slight penalty to Plan C as compared to Plan A. If this difference is significant, the capacity of Plan C would be enough less than that of Plan A that the latter plan would probably be preferable. However, if operations to the south were to be conducted at the same or nearly the same rate on both layouts, that of Plan C might be preferable. Plan C offers a substantially greater IFR capacity than does Plan A when operations are controlled by prevailing winds from the north. Plan C would also permit construction of shorter taxiways from a centrally located terminal than would Plan A, an advantage that would yield operating economies.

Plan B would clearly provide the maximum capacity for Newark Airport. In addition to simultaneous IFR approaches and de-

partures on the two main runways, which could be made under current procedures and regulations, it may be that future aircraft and air traffic control equipment and procedures would permit simultaneous landings under IFR conditions. Such a development, if accomplished, would permit the capacity of Plan B, and only Plan B, to be increased to more than twice the capacity of the present-day Newark Airport.

NEW CONSTRUCTION REQUIRED

Implicit in each of the five runway systems examined is the concept of intensive use of the 2300 acres of the airport. The plan released by the Port Authority, showing a new passenger terminal building, a parking area, a number of highway interchanges, and additional air cargo, air line hangar, and fuel storage areas, is clear indication of the extensive degree of land development which may be anticipated from the creation of a first-class jet airport on the site.

Much of the airport is meadow-marsh, and an extensive drainage system will be required under any plan for expansion. Construction would probably be preceded by a period during which treatment of the soil would be accomplished by one or more methods to provide a suitable foundation for the following construction. The costs of drainage and treatment would not vary greatly from one airport plan to another. Runways, runway turnoffs, taxiways, holding pads, terminal aprons, and aircraft parking stands would require expenditures roughly in proportion to the capacity and range capability which it is decided to plan for.

However, each of the proposed plans would require certain new construction not required by the other plans:

The Port Authority's Plan retains the existing control tower. Technically, the upper sixty feet or so of the tower and radome would violate the side clearance surface of the new instrument runway; however, the FAA might grant an exception to these clearance requirements as set forth in its Technical Standard Order N-18. Should compliance with the order be required, a new location would have to be selected for the tower. Plans A_1 and A, which are expansions of the Port Authority's

plan, would require no other important alterations to the site. Some blast protection might be required for the protection of traffic on North Avenue from jets taxiing to and from Runway 4R.

Plan B would require relocation of the tower. Runway 11R-29L might be built far enough south of the location shown for it on Figure II to permit retention of the tower as it is now; however, access to a tower and land use of the area isolated by intersecting runways would be a problem. Extension of Runway 11L-29R across U. S. 1 would require a considerable amount of highway construction. A portion of the highway would have to be depressed and the interchange with the Frelinghuysen Avenue connector would have to be relocated. A pumping installation would be required for drainage of the depressed portion of the highway.

Because it would be desirable to avoid an intersection at Runway 4L-22R with Runway 11L-29R, the south end of the former, if developed to a full 10,000-foot length, would extend to within a few hundred feet of North Avenue. If a level instead of a sloping gradient were selected for Runway 4L-22R, a local relocation of North Avenue might be required.

The passenger terminal area in Plan B would lie between the two north-south runways. Since the most convenient access to such a terminal would be from the west, a vehicular tunnel would be needed under Runway 4L-22R and its taxiway.

Plan C would require the terminal building and the patrons' parking lot to be in the area enclosed by the runways, and would also require an access tunnel. Access could be made on either the west or the north side of the airport. Because of the more limited space available within the runways for terminal purposes, it would be necessary to plan initially the ultimate development of the terminal area so that expansion could take place as required in an orderly manner.

Under Plan C the existing control tower would remain in its present location.

AIRCRAFT OF THE 1970'S

SUPERSONIC TRANSPORTS

It is now becoming increasingly evident that a foreign-built, medium-range, Mach-2 transport may be certificated and ready for airline use toward the end of this decade. It also appears at present that a United States-built, long-range, Mach-3 transport may be ready for use within a few years thereafter.

Up to this point, this report has been concerned only with conventional jet aircraft of the type in use today, because these are expected to be virtually the sole means of air transport throughout this decade and the primary means well into the next.

However, in planning the development of Newark Airport, the longer-range future should be kept in mind as well as the remainder of this decade. Building for the 1965-'70 period would be shortsighted if the airport were to become obsolete in the 1970's.

To the best of our ability to judge today, Newark Airport, if developed according to any of the plans described, would be adequate or could readily be modified to serve the supersonic transports of the 1970's.

VERTICAL/STEEP TAKEOFF AND LAND TRANSPORTS

Development of this family of aircraft is continuing to make good progress. Recently, contracts were awarded to United States aircraft manufacturers to build prototype aircraft of a size capable of carrying 40 passengers. In Europe, more advanced aircraft have been flying for some time. Continuing improvements in helicopter design appear to be keeping this type of aircraft competitive with the rest of the V/STOL family.

Widespread use of this type of aircraft would involve more problems, however, than those of providing the proper equipment. The problem of operating costs vs. subsidy is a more difficult one. At present, it is the policy of our government to reduce subsidies, but extensive operation of V/STOL transports would probably require more subsidies, at least initially. Other problems are the availability of suitable landing sites in optimum downtown locations and the gaining of public acceptance of new noise levels in these areas arising from the operation of such aircraft.

Taking all of these and other considerations into account, it appears reasonable to assume that this type of operation will comprise a small but growing segment of all air transport during the 1960's, but not before the early 1970's will it begin to become a major part of the industry.

For the A-type plans and Plan B, we see no problem in accommodating V/STOL aircraft in the future at Newark Airport. For Plan C, the accommodation of such aircraft would also be possible; however, a greater amount of initial study and planning for this development would be advisable because of the more limited space available within the runway pattern.

ACCESSIBILITY OF NEWARK AIRPORT

An airport serves a community or a region to the extent that use is made of its facilities. Since its major function is to facilitate the transport of people, its use and the service it renders will be in proportion to its accessibility. An airport which is conveniently located with respect to a million people will offer far more schedules and handle far more passengers than would one that served the same community from a less accessible location.

Newark Airport lies at the hub of existing and developing high-capacity, limited-access highways. By the Garden State Parkway, the New Jersey Turnpike, new Interstate Routes 278, 78, 80, and 280, and other major highways, four and one-half million residents (of New Jersey's six million) who live in twelve New Jersey counties are within one hour's driving time of Newark Airport. This is half the time required for many of New Jersey's residents to drive to New York International Airport. With construction of Interstate Route 95, Trenton will be less than fifty non-stop miles away.

From midtown Manhattan, Newark is fifteen miles away, closer than New York International Airport. Across the new Narrows Bridge, even parts of Brooklyn will be closer; Staten Island is only six miles away.

Within ten miles of Newark Airport, in some forty New Jersey communities, live a total of 1,900,000 people. If we include the residents of Staten Island, this total becomes 2,100,000 people.

No other feasible airport site in Northern New Jersey can compare with Newark Airport in ease of access for so many millions of people.

As the time approaches when suburban rapid transit will begin to serve the needs of the metropolitan area, Newark Airport will be well situated to receive the service which may be available. The Central Railroad and the Pennsylvania Railroad from the south pass close by the site. By an extension of service of the Hudson and Manhattan and an interconnection, the extensive areas of New Jersey to the west and north can be served by the Erie-Lackawanna. The Hudson and Manhattan, in addition, could provide direct service from lower and midtown Manhattan.

In potential rapid transit service then, as well as in highway access, Newark Airport is not equalled by any other feasible airport site.

ECONOMIC EFFECT ON NEW JERSEY

The most direct economic effect of an airport upon a community is in its payrolls and employment. While airport employment includes all categories of job types from laborers to executives, it requires a higher proportion of skilled clerical, technical, and administrative personnel than most industries. A large airport employment, therefore, is a distinct asset to surrounding communities.

Employment at Newark Airport presently is approximately 4300, with an annual payroll of $33,000,000, for an average yearly salary of about $7700. This employment is a function of the level of activity, increasing with number of aircraft operations, number of passengers, the growth of air cargo operations, the extent to which aircraft maintenance operations are carried on, and other factors.

It is assumed that Newark Airport will reach its ultimate operating capacity at essentially the same time that the region's airports as a whole reach their combined ultimate capacity. On the basis of available information, it appears that this would be about 1968 to 1970, depending on the type of development at Newark Airport. The type and degree of development, in turn, will determine to a large extent the ratio which airport employment will bear to airport activity. The current ratios of employment to passengers handled and to aircraft operations annually at Newark Airport is below the average for the same ratios of employment to activity at the three metropolitan airports combined. For the three airports combined, there is one airport job for every 13 airline operations, or one job for every 440 airline passengers handled. At Newark Airport, on the other hand, current employment is at a rate of one job for every 27 airline operations, or one job for every 680 airline passengers handled.

If the airport were to remain substantially as it is today, an ultimate level of about 5200 employees earning $40,000,000 annually could be expected. However, if Newark Airport's capacity and range capability were to be significantly increased, and if the ratios of employment to activity at such an expanded facility were to become equal to the current average calculated for the three metropolitan airports, these figures should be expected to *double* or *triple.*

For every three jobs at the airport, there will be one additional job directly concerned with the airport's work but at a location away from the airport.*

For every five airport-connected jobs, there are seven additional jobs directly resulting from the economic benefits of the airport and its activity.* These include jobs with suppliers to the airport and its users, additional jobs at the hotels, restaurants and stores that benefit directly from the passenger traffic through the airport, and jobs with additional and enlarged business establishments providing the goods and services for the increased number of employed people.

Altogether we estimate that development of Newark Airport could result in an additional payroll of $200,000,000 to $270,000,000 by 1970 in the area around Newark Airport.

The question of an airport's impact on the values of nearby properties has been the subject of a number of investigations, over a period of ten years or more. While the relationship between property values both near to and at some distance from an airport and the change

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**The Economic Relationship of Air Transportation to the Economy of the New Jersey-New York Metropolitan Area,* Corporation for Economic and Industrial Research, August 1960. (A study prepared for the Port of New York Authority.)

in this relationship during the development and growth of the airport and its traffic is, to some extent, unique at each airport, there is evidence showing that even a heavily-used jet airport has negligible adverse effects on the values of nearby residential properties and may cause an appreciation in such property values.* For every resident who becomes adversely affected by the airport's activities to such an extent that he chooses to move, it appears that there is a prospective purchaser who values close proximity to the airport area for its convenient transportation, the convenience to the job it creates for him, or some other reason.

It may also be concluded from developments elsewhere that industrial sites close by airports are attractive for various reasons to a wide variety of types of industry. While many of these industries are aviation-connected in some way, many others are not, and seem to choose sites near airports for reasons which are not readily apparent. We can only conclude that any adverse effects that may be caused by the proximity of a plant to an airport are considered minor drawbacks by some industries when sites are selected for new plants. In our opinion, there appears to be at least as much market for industrial sites near airports as for otherwise comparable sites elsewhere.

A Study of the Impact of Airports on the Market Value of Real Estate in the Adjacent Areas, H. O. Walther, M.A.I., 1960. (A study prepared for the Port of New York Authority.)

CONCLUSIONS

Newark Airport is considered the best all-weather airport in the Metropolitan Area. Today it ranks about 9th among major American airports in the handling of airline air traffic. It is strategically located with regard to major highways serving northern and central New Jersey and is less than 30 minutes by limousine from midtown New York. It is unique with regard to its location with major rail lines and lends itself rather readily to rapid transit connections with service to Newark, Jersey City, and New York. Whether such connections would be economical would require further detailed study and would be dependent upon the development, growth, and use of Newark Airport.

Airport traffic early in 1961, prior to the limited use of jet aircraft at Newark, indicated a falling-off from the previous year. Published airline schedules reflected this condition and visits to the airport clearly revealed the reduction in its use. Without doubt, the amount of air traffic affects the general economy of Newark in particular and Metropolitan Northern New Jersey in general. We believe that it would be reasonable to assume that, if no improvements were to be made to Newark Airport and if no jets were permitted to operate in and out of Newark, the airport in a few years would cease to be an air carrier airport and would serve only general aviation and scheduled local airline operations.

Physically, Newark Airport can be expanded so as to continue to be a major airport and to become capable of serving both short- or medium-range operations *and* long-range or transcontinental aircraft. It is presently providing short- and medium-range service with a somewhat restricted capacity. Additional runways and other improvements as recently proposed by the Port of New York Authority would increase the

present capacity and make the airport more attractive to the airlines and, naturally, more desirable to the flying public. Such improvements would be economical and entirely suitable for short- and medium-range flights made by current equipment. They would not, however, be economical for long-range non-stop flights because of the severe load restrictions that the proposed runways would impose.

Somewhat greater non-stop range may be achieved from shorter runways in the next ten years or so by virtue of continuing progress in aeronautical research and development. However, the tremendous investment represented by the conversion of the trunk airline fleets to current jet equipment will require long runways for many more years wherever scheduled, long-range, non-stop service is conducted. It is physically possible to construct runways adequate to support such service at Newark Airport, and our report has discussed three ways in which such runways can be aligned.

The longer runways could be built initially to their full length or in stages consistent with economics and needs. It would only be necessary to make plans for the type and number of stages of construction. Any major improvement will require from three to five years to carry out to completion. In other words, it would be possible to build now for immediate expansion needs to serve the short- and medium-range traffic volume requirements and then add, when needed, runway extensions for transcontinental flights, if at that time equipment in use were not suitable for long-range flights from the available runways.

Although the capacities and advantages and disadvantages of the schemes studied have been noted, no attempt has been made to determine the exact amount of traffic which will be using this airport in the next 5 to 10 years. How this traffic demand would be correlated with the airport needs of the entire New Jersey-New York Metropolitan Area is, of course, not a part of this study.

Probably the most serious problems in the establishment or expansion of a jet airport are noise abatement and the effects of noise on the neighborhood surrounding the airport. The plan recently proposed by the Port of New York Authority, because of its positioning of the runways, would probably reduce slightly the noise pressure levels over inhabited areas. However, more frequent operations would increase somewhat the frequency of these noises. All in all, this layout would probably result in the noise situation being about as it is now.

Longer runways for transcontinental flights would result in some increased noise from certain flights under certain conditions. Such flights would be only a small proportion of total flights, and regulations similar to those now in effect could keep all other flights generally within the present "noise pattern."

The establishment of buffer zones on community lands adjacent to the ends of the runways is one of the most effective means of dealing with the noise problem. Areas under the takeoff and approach paths that are being used for commercial and residentail purposes can be rezoned for other land uses, such as park, recreational, light industrial, or others associated with relatively light concentrations of people. Such land uses, in addition to reducing the numbers of people who are exposed to high sound pressure levels, also reduce the already remote hazards posed by aircraft operating at low altitudes.

The expansion of an airport may be carried out in stages correlated with an orderly schedule or program of rezoning and redevelopment in sections of nearby communities. By such action, the growing needs for adequate air transportation in a large metropolitan area can be satisfactorily met while the economic advantages that thriving and successful business, industry, and commerce bring to the nearby communities are being retained. Action of this kind would undoubtedly be most helpful in solving many of the problems of Newark Airport.

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